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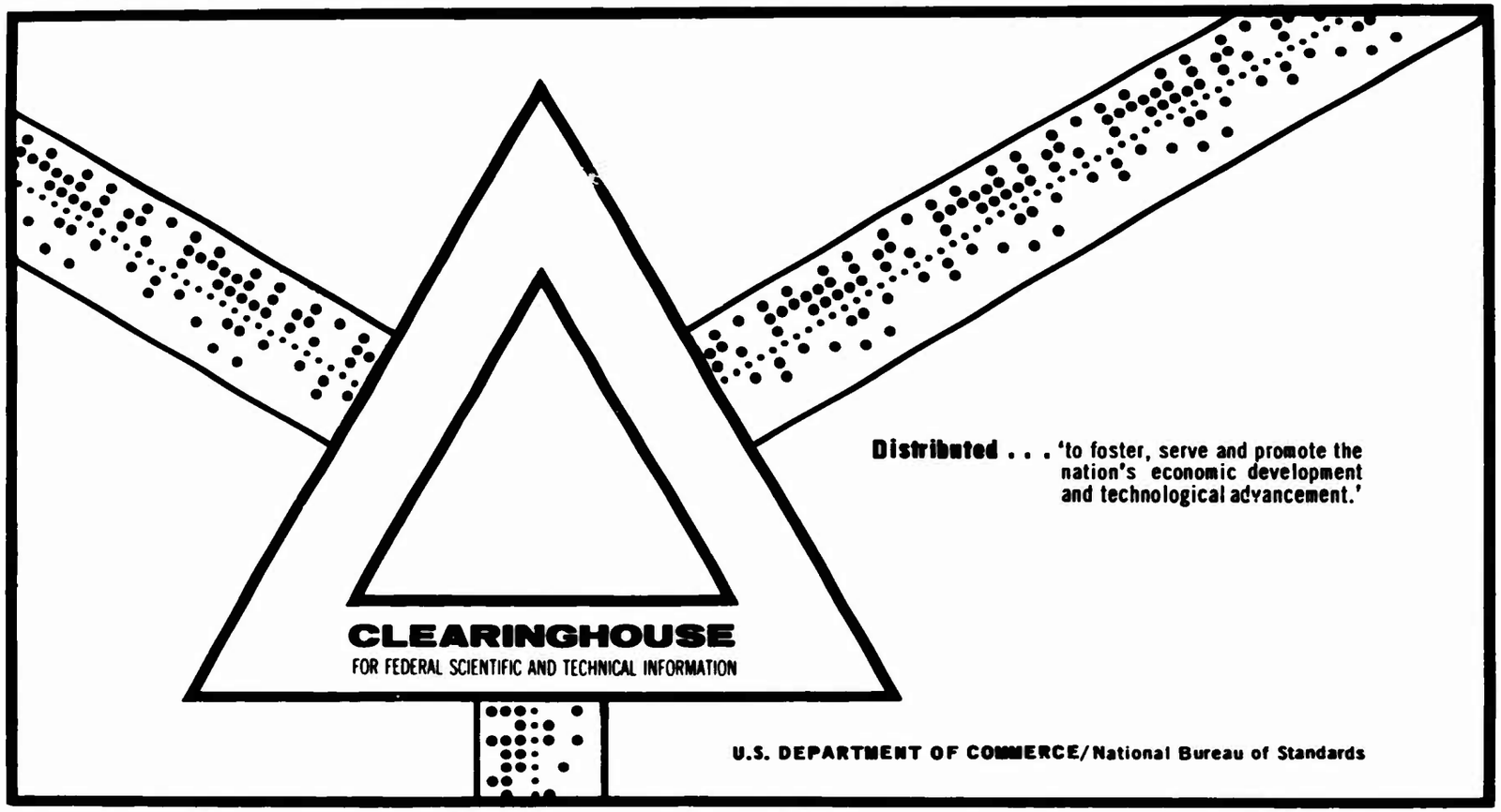

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SUMMARY PAGE

THE PROBLEM

Evaluation of a new standardized method for quantifying Coriolis (motion) sickness by means of a conventional rotary chair.

FINDINGS

With this method the subject is required to move his head within a standardized time and space pattern while the chair rotates at an individually preselected constant velocity. Such movements evoked the common endpoint of severe malaise (M III) in 98.8 per cent of the 250 normal subjects. Susceptibility was scaled by the magnitude of the stressor stimulus and scored (Coriolis Sickness Susceptibility Index, CSSI) as the number of head movements executed at a given chair velocity in reaching the test endpoint, multiplied by the stressor effect ($\bar{E}$ factor) of each head movement as previously determined for each chair velocity. In most cases the test velocity that evoked M III within the set limits of 40 and 166 head movements could be predicted on the basis of the subject's past history of motion sickness. The frequency distribution of CSSI values of the normal subjects was markedly right skewed on an arbitrary scale of 0 to 100 points; 90 per cent fell within 0.4 and 26.0 points. High test-retest reliability was found for both the CSSI scores (ρ = .89) and pattern of symptomatology. At the M III level, mild nausea, epigastric awareness, or discomfort was manifested by the majority of the group, but 9.6 per cent reached this level completely free of these symptoms. Three of the normal and the three labyrinthine-defective subjects were unsusceptible (CSSI = 100) to the maximum vestibular stressor conditions of this test. High reliability, simplicity, minimal time, conventional apparatus, and quantitative scaling of susceptibility are advantages of this new standardized test.

INTRODUCTION

Individual differences in motion sickness susceptibility have been scored by a pass-fail dichotomy designed primarily for screening hig / susceptible individuals and have been ranked according to the level of response to some type of sustained stimulus. However, no known method has yielded a numerical score that would permit comparison of individuals on a continuous scale of susceptibility values. Such a procedure has two major requirements: 1) standardization and quantitative definition of symptoms that are reliably diagnostic of a specific level of motion sickness; 2) choice of a stimulus that is effective for the majority of normal subjects and which, for practical purposes, can be generated by simple or conventional apparatus and be readily measured.

The endpoint favored by most investigators of motion sickness susceptibility is the demonstration of frank sickness, viz, severe nausea or vomiting. Such a criterion has certain disadvantages, however, inthat physiological as well as psychological complications can affect serial measurements (e.g., drug or habituation studies). A more acceptable and definitive approach considers diagnostic criteria based upon symptomatology manifested prior to this severe expression of motion sickness. A guideline for such an approach has recently been proposed (1) which, in quantitative terms, categorizes specific symptoms and identifies five levels of severity of motion sickness. Each of the four endpoints short of frank sickness allows the experimenter to stress his subjects to a nearly equivalent extent without the manifestation of severe symptoms. This choice in the test design of an equivalent response criterion, instead of a common schedule of physical forces for all subjects, was made to gain greater differentation of individual differences, as well as to spare highly susceptible individuals from undue stressor effects and to eliminate the possibility of regarding more resistant ones as immune to motion sickness.

Of the various available means of experimentally provoki g symptoms of motion sickness, standardized head (body) movements during constant speed rotation in a rotational chair represent a convenient and highly effective method (2-7). The present study evaluated a variation of this general method, but one which was designed specifically to measure individual susceptibility along a common scale of stress with an equal endpoint. The dependent variable was a quantitatively defined malaise level and the independent variable, the physical dimensions of a standardized Coriolis stimulus.

PROCEDURE

SUBJECTS

The normal group consisted of 250 men, of whom 193 were aviation students or flight crew personnel; the remaining 57 were comprised of 11 nonaviator officers, 41 enlisted men, and 5 civilians with flying assignments. Their ages ranged from 16 to 43 years; all but 18 were between 19 and 26 years of age.

In addition to the standard medical examination required by the Navy Department, all subjects were given specific tests of otolith (ocular counterrolling) (8, 9) and semicircular canal function (caloric threshold (10), and oculogyral illusion threshold (11)). Each of the normal subjects manifested vestibular responses which were well within normal limits.

Three completely deaf persons with total or severe bilateral loss of semicircular canal and otolith function (12) acted as control subjects.

METHOD

The procedure for measuring motion sickness susceptibility to Coriolis forces included a pretest evaluation of the subject for individual selection of stimulus level (chair velocity) and general fitness; a simple method of scoring diagnostic criteria of motion sickness (Table I); and the grading of an individual in terms of a quantitative measure (index) of Coriolis sickness susceptibility derived from the cumulative head movements executed at a given chair velocity.

The predetermined endpoint for each subject was severe malaise (M III). The desired level of motion stress imposed upon each subject was such that this level of malaise was approached rather gradually so that the observer could readily identify and register symptoms in sequence as they were manifested, but more importantly, so that the subject was not overstimulated, particularly to the point of extreme nausea or vomiting (frank sickness). For these reasons, the Motion Experience Questionnaire (MEQ) (Appendix A), based on the Pensacola Motion Sickness Questionnaire (13), was used in conjunction with Table II as the basis for selecting the rotational rate for testing each subject.

Table II lists the best estimate of the chair's rotational test rate (rpm) which we were able to gain empirically from the average level of experience ($\underline{X}$) and intensity of symptoms ($\underline{S}$) reported in the MEQ. Usefulness of Table II is demonstrated by the fact that, by this table, an rpm could be predicted which yielded M III in approximately 80 per cent of the 250 subjects, at between 40 and 166 head movements on the first trial.

The subject's fitness for testing was established from his completed Preexperimentation Questionnaire (Appendix B). After both questionnaires were evaluated, the subject was briefed on the symptoms he could expect. Then he was secured by a lap belt in the Stille rotary chair and a blindfold was put over his eyes to eliminate any visual influences.

While stationary, the subject was required to demonstrate the standardized head movement sequence which would provide the Coriolis accelerations during chair rotation: front, upright, pause; right, upright, pause; back, upright, pause; left, upright, pause; front, upright, rest (Figure 1). Each 90° tilt movement or the return to upright was executed smoothly over a 1-second period. The pauses between movements were of the same (1 second) duration, with the final pause (rest) lasting for 20 seconds.

Table I

Diagnostic Categorization of Different Levels of Severity of Acute Motion Sickness

Category	Pathognomonic 16 points	Major 8 points	Minor 4 points	Minimal 2 points	AQS* 1 point
Nausea syndrome	Vomiting or retching	Nausea† II, III	Nausea I	Epigastric discomfort	Epigastric awareness
Skin		Pallor III	Pallor II	Pallor I	Flushing/Subjective warmth ≥II
Cold sweating		III	II	I	
Increased salivation		III	II	I	
Drowsiness		III	II	I	
Pain					Headache ≥ II
Central nervous system					Dizziness Eyes closed ≥ II Eyes open III

Levels of Severity Identified by Total Points Scored

Frank Sickness	Severe Malaise	Moderate Malaise A	Moderate Malaise B	Slight Malaise
(S)	(M III)	(M IIA)	(M IIB)	(M I)
≥16 points	8 - 15 points	5 - 7 points	3 - 4 points	1 - 2 points

*AQS - Additional qualifying symptoms. +III - severe or marked, II - moderate, I - slight.

Table II

Rotary Chair Test Velocities Most Often Associated with Average Experience and Symptom Levels Coded from Motion Experience Questionnaires

M III		SYMPTOMS S										
		0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
EXPERIENCE X	0.5	10.0*	10.0	10.0	10.0	10.0	10.0	10.0	7.5	5.0	5.0	5.0
	1.0	12.5	12.5	10.0	10.0	10.0	10.0	10.0	7.5	5.0	5.0	5.0
	1.5	12.5	12.5	12.5	10.0	10.0	10.0	10.0	7.5	7.5	5.0	5.0
	2.0	12.5	12.5	12.5	12.5	12.5	10.0	10.0	10.0	7.5	5.0	5.0
	2.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	10.0	7.5	5.0	5.0
	3.0	15.0	15.0	12.5	12.5	12.5	12.5	12.5	12.5	10.0	7.5	7.5
	3.5	20.0	15.0	15.0	15.0	12.5	12.5	12.5	12.5	10.0	7.5	7.5
	4.0	25.0	20.0	15.0	15.0	15.0	15.0	12.5	12.5	10.0	7.5	7.5
	4.5	30.0	25.0	20.0	20.0	20.0	15.0	15.0	12.5	10.0	7.5	7.5
	5.0	30.0	30.0	25.0	25.0	25.0	20.0	15.0	12.5	10.0	7.5	7.5

*Rotary Chair Velocity (rpm)

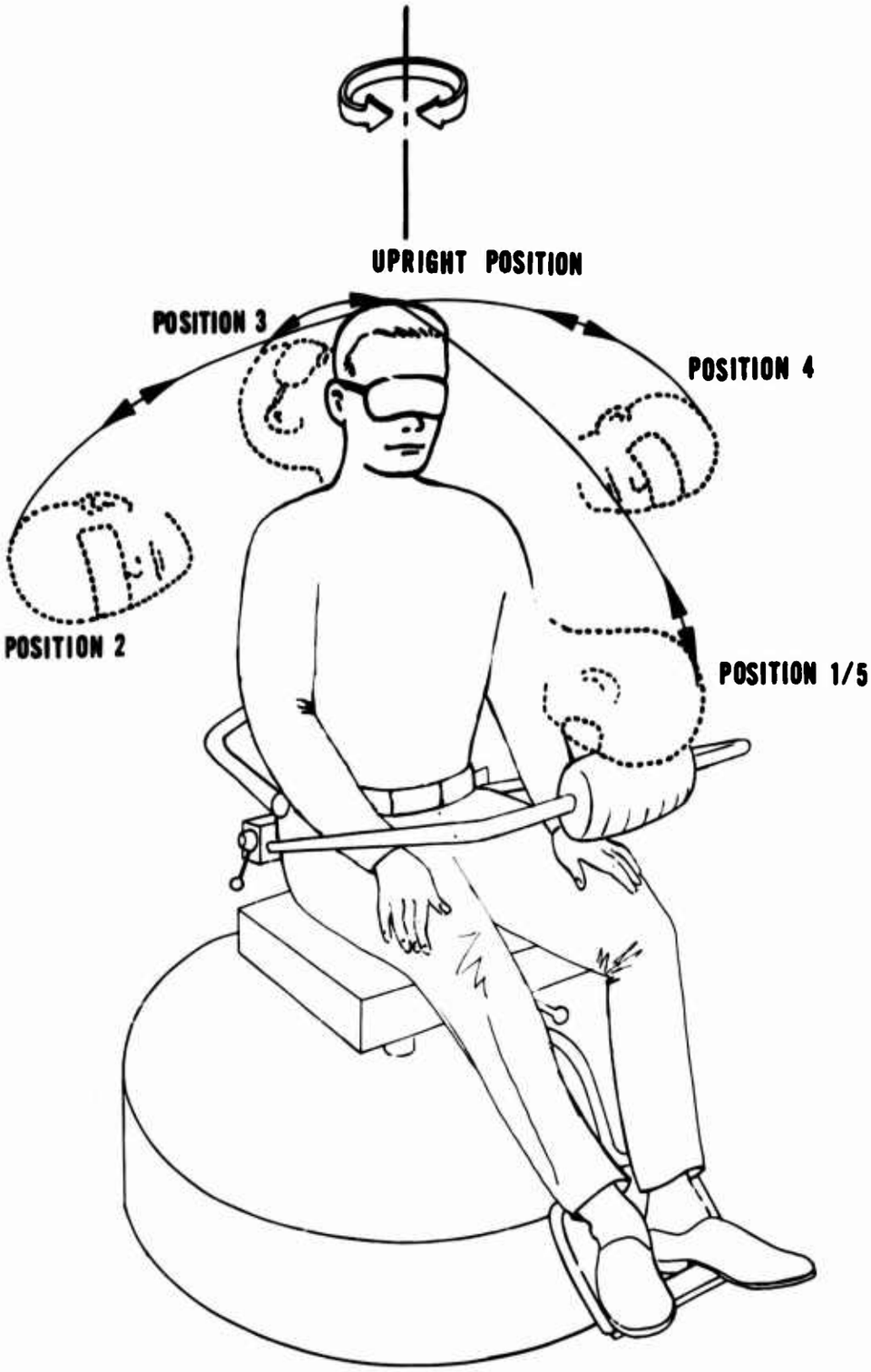

Figure 1

Diagram of standardized Procedure for Making Each Sequence of Head Movements To and From Tilt Position 1 through 5 During Chair Rotation

A taped recording was used to standardize the temporal sequence of head movements.

With the subject in an upright position, the chair was accelerated 5°/sec^2 either in the clockwise or counterclockwise direction, selected at random, until one of several constant velocities was reached (2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 25.0, 30.0 rpm). Sixty seconds later the test was begun with the first head movement sequence. The sequences were continued until the cumulative point score of the symptoms totaled at least 8, the lowest number of points in the M III criterion (1). Immediately upon manifesting M III, the subject terminated his head movements and returned to his upright position; the chair was slowly decelerated (0.5°/sec^2) to a stop. Specific motion sickness signs and symptoms were scored on a tally sheet (Appendix C) as they appeared. With this aid, even an observer with only a minimal amount of training could record the symptomatology efficiently and stop the test precisely when the endpoint was reached.

The Coriolis Sickness Susceptibility Index

The stress effect of a standard head tilt as a function of chair velocity was measured in another study (unpublished data) by determining among several subjects the number of head tilts required to elicit a common malaise level at each of several different chair velocities. Individually, the regularity of this function was limited to rotational rates above a critical amount, that which apparently stressed the subject beyond his functional vestibular reserve (FVR) (14). When the rpm was reduced below this point, there was characteristically a sudden marked increase in the subject's capacity for making head movements without evoking symptoms.

When head movements at a given chair velocity introduce vestibular stress in excess of the FVR, the average relative stimulus effect of a single head movement* can be expressed by the factor E, which is linearly related (log/log function) to chair velocity (Figure 2) (unpublished data). Each individual's score, referred to as his Coriolis Sickness Susceptibility Index or CSSI, therefore, can be calculated simply by multiplying the appropriate E factor for the rpm used in his test by the number of head movements (N) required to elicit M III:

$$CSSI = E \times N$$

The resultant value expresses quantitatively motion sickness susceptibility to Coriolis acceleration within a single convenient scale of numbers (0-100).

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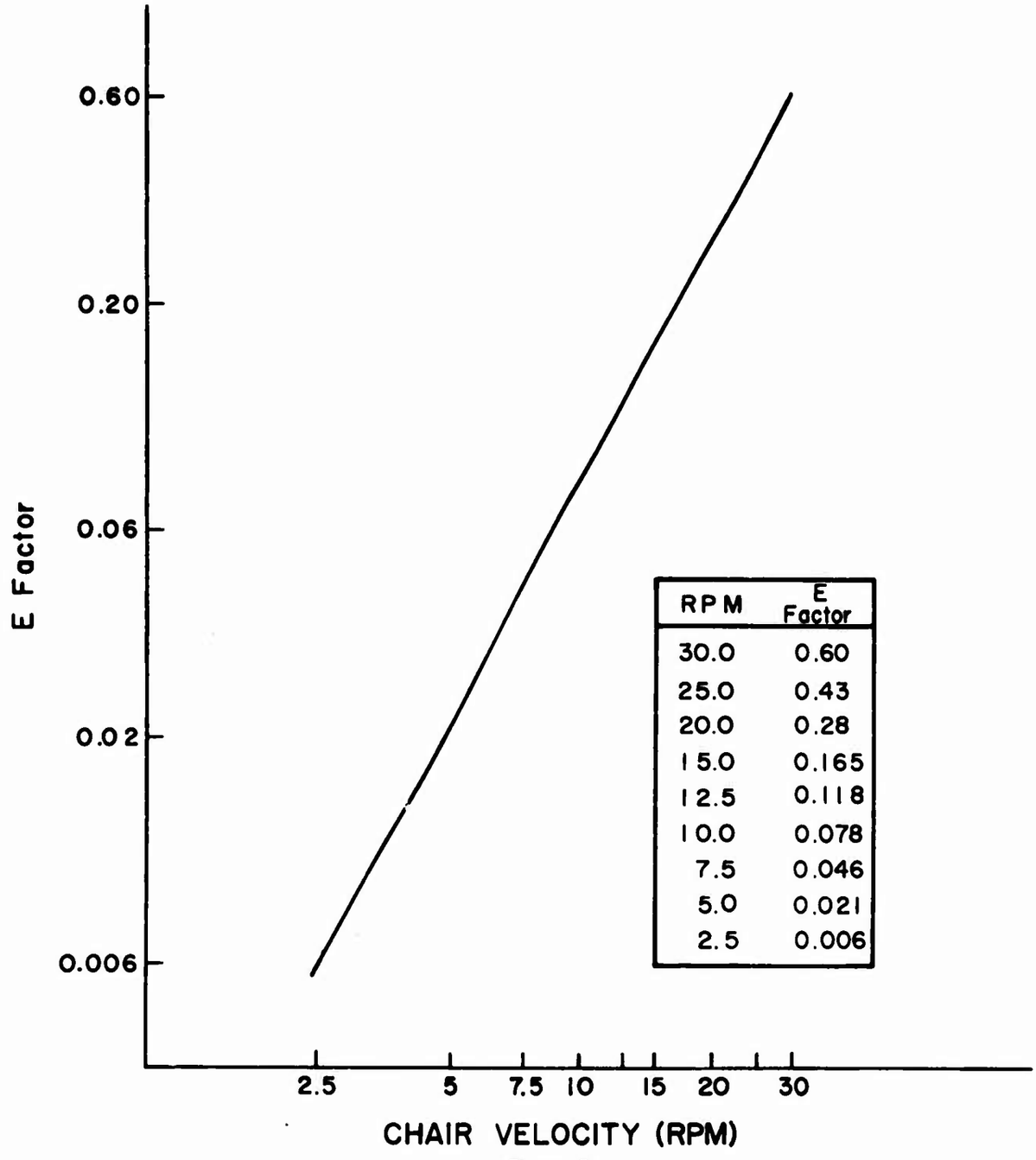
*Head movement in the four directions as required in this test is not equally stressful (15, 16), and the effect of direction of movement varies among individuals and occasionally even in the same individual.



RPM	E Factor
30.0	0.60
25.0	0.43
20.0	0.28
15.0	0.165
12.5	0.118
10.0	0.078
7.5	0.046
5.0	0.021
2.5	0.006

Figure 2

Relationship Between Average Relative Stress Effect ($\bar{E}$ Factor) of a Single Head Movement and Rotational Velocity

It was found in the program of this test's development that when M III occurred within the range of 40 to 150 head movements, the signs and symptoms developed regularly and gradually without the hazard of provoking frank sickness. If M III was not reached within this range, the test was considered invalid and the subject was retested after at least 48 hours had elapsed. Any subject tested at 30 rpm who failed to reach the endpoint was not retested since his performance was considered to indicate essential immunity to Coriolis sickness. In the retest the chair was rotated in the opposite direction from that of the first test and at a different rpm that was based on the subject's response in the initial test. The duration of each test was usually less than 15 minutes.

Test-Retest Evaluation

Thirty unselected subjects whose susceptibility level (CSSI score) had been properly measured were retested at the same rotational rate to determine test-retest reliability. The standard Spearman (rank) method revealed the degree of relationship between the rankings of the individual CSSI scores calculated for the two test sessions.

RESULTS

NORMAL SUBJECTS

Symptomatology

The frequency with which each of the diagnostic categories of symptoms appeared among the normal group at the level of M III is presented in Figure 3.

The incidence of each category of symptoms, which in most cases were classified as mild (I), moderate (II), or severe (III), was as follows: epigastric awareness, epigastric discomfort or nausea I, 90.4 per cent; pallor (I, II), 84.4 per cent; cold sweating (I, II, III) 66.8 per cent; flushing/subjective warmth ($\geq$ II) 72.4 per cent; increased salivation (I, II) 37.2 per cent; dizziness ($\geq$ II) 25.6 per cent; drowsiness (I, II) 21.6 per cent; headache ($\geq$ II) 1.2 per cent.

Use of the M III criterion as an endpoint in this test prevented the evocation of severe levels of increased salivation, pallor, or drowsiness; only four subjects manifested any degree of cold sweating at this level. Nausea did not exceed the mild level, and in fact 9.6 per cent of the subjects remained completely free from any epigastric involvement whatsoever.

Coriolis Sickness Susceptibility Index

The distribution of Coriolis Sickness Susceptibility Index values for all subjects is plotted in Figure 4. The values ranged from 0.4 to 100.0, but the distribution is markedly right skewed (mean = 15.3, median = 10.0, mode 7-8); 90 per cent of this population fell within 0.4 and 26.0 points. Table III lists CSSI values in terms of percentile scores.

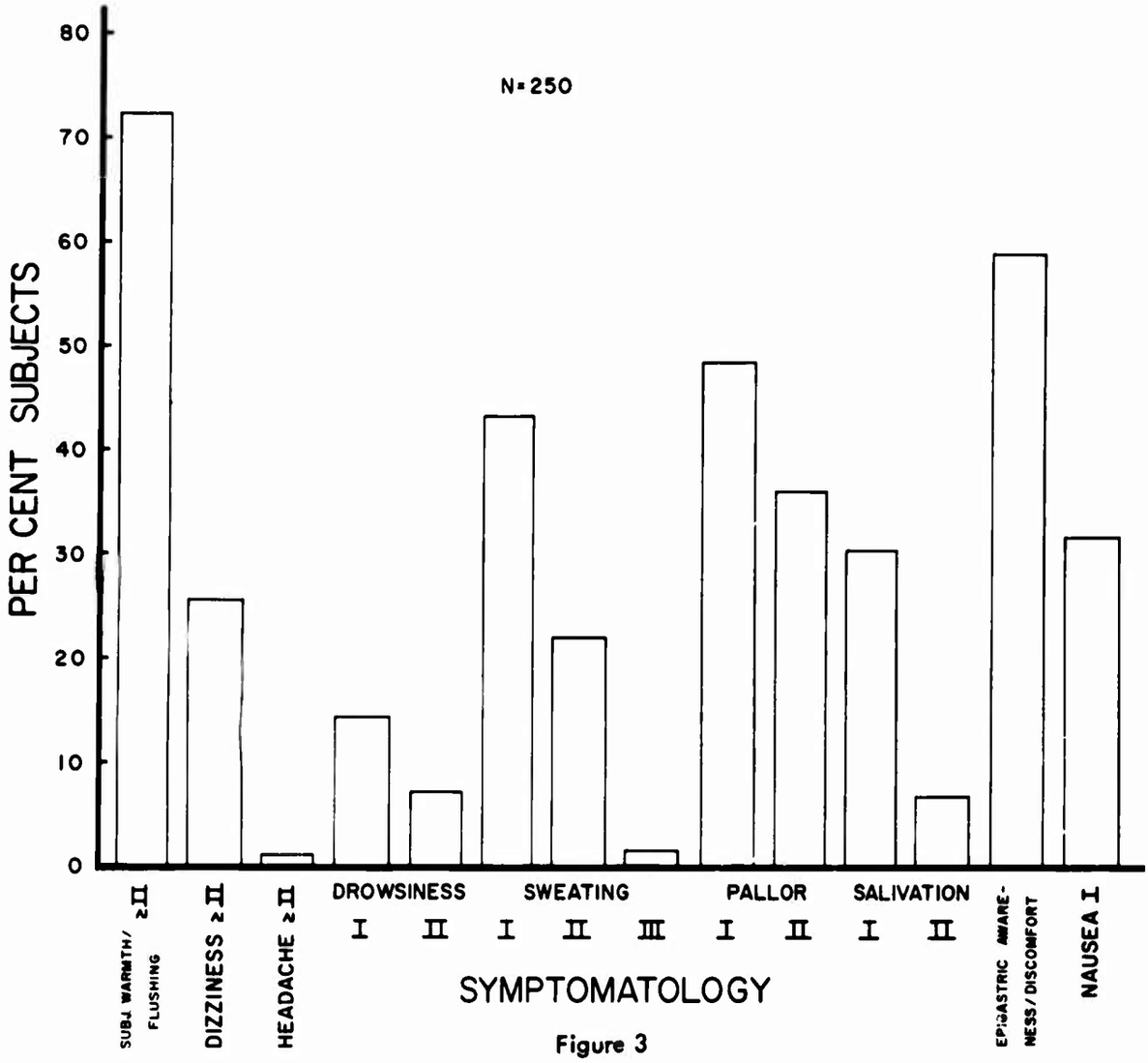


Figure 3

Frequency of Occurrence Among 250 Normal Subjects of Specific Diagnostic Symptoms Associated With Malaise III

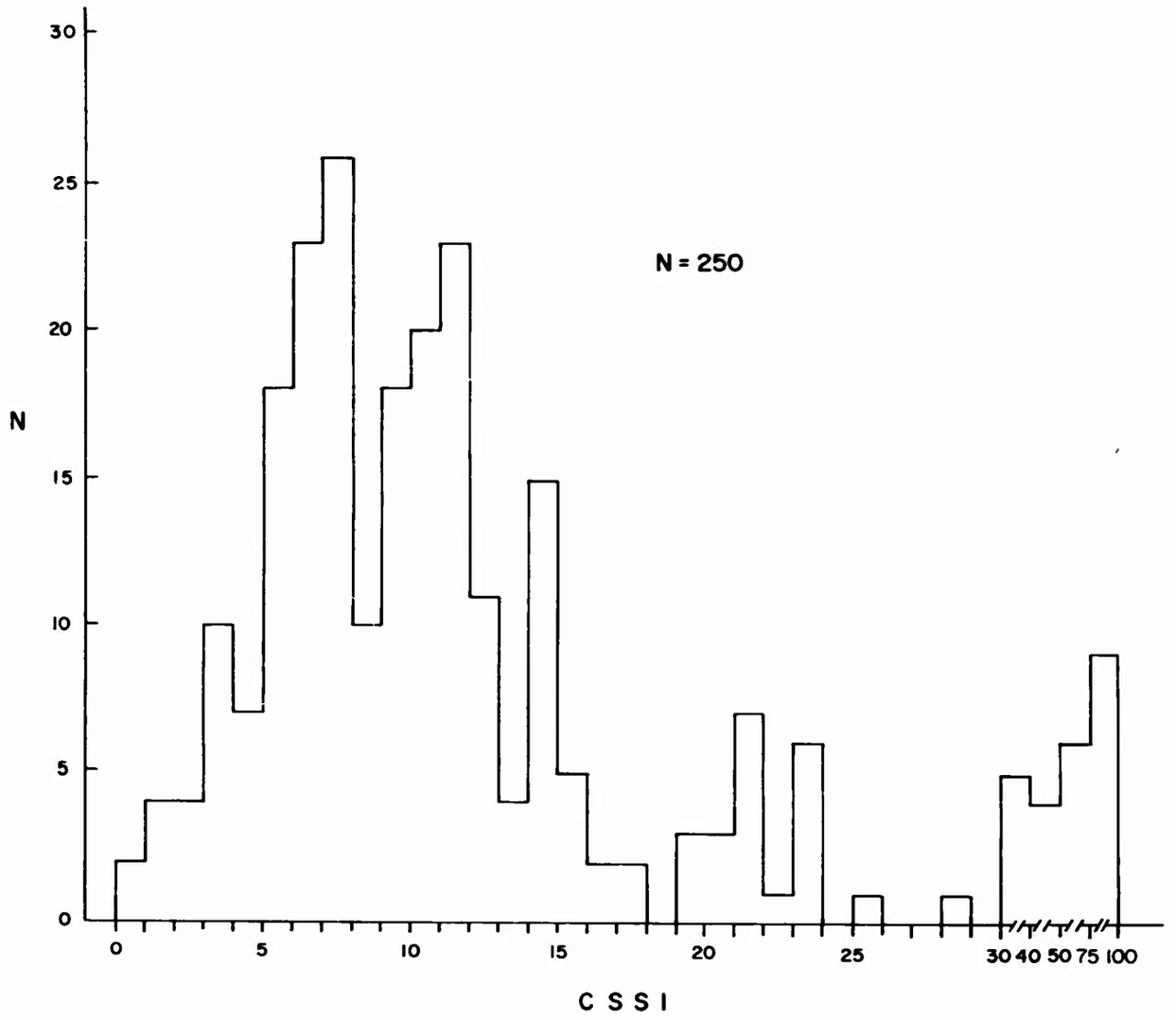


Figure 4

Distribution of Coriolis Sickness Susceptibility Index (CSSI) Among 250 Normal Subjects

Table III

Coriolis Sickness Susceptibility Index (CSSI) Values
Represented by Various Percentile Scores

CSSI	Per Cent	CSSI	Per Cent
1.1	1	11.3	60
3.2	5	12.9	70
4.7	10	16.0	80
6.2	20	26.0	90
7.2	30	58.0	95
8.6	40	91.5	99
10.0	50		

The schedule of chair velocities was found to be adequate to test a wide spectrum of susceptibility to Coriolis motion sickness in this population, although the maximum rotational rate did not provoke symptoms in three of the 250 subjects.

Test-Retest Reliability - The Coriolis Sickness Susceptibility Index of 30 subjects as determined with the M III criterion in test and retest sessions correlated highly (ρ = .89). A scattergram plot (Figure 5) reveals that none of the subjects changed substantially in his level of susceptibility from one session to the next.

The patterning of symptoms for the group was remarkably similar (Figure 6) in these two test sessions and, individually, almost identical symptoms in terms of number, type, and intensity, were provoked in the majority of cases.

LABYRINTHINE-DEFECTIVE (L-D) SUBJECTS

None of the L-D subjects experienced even the slightest symptom or unpleasant feeling during or following the execution of up to 300 head movements at the highest rotational velocity of the chair (30 rpm).

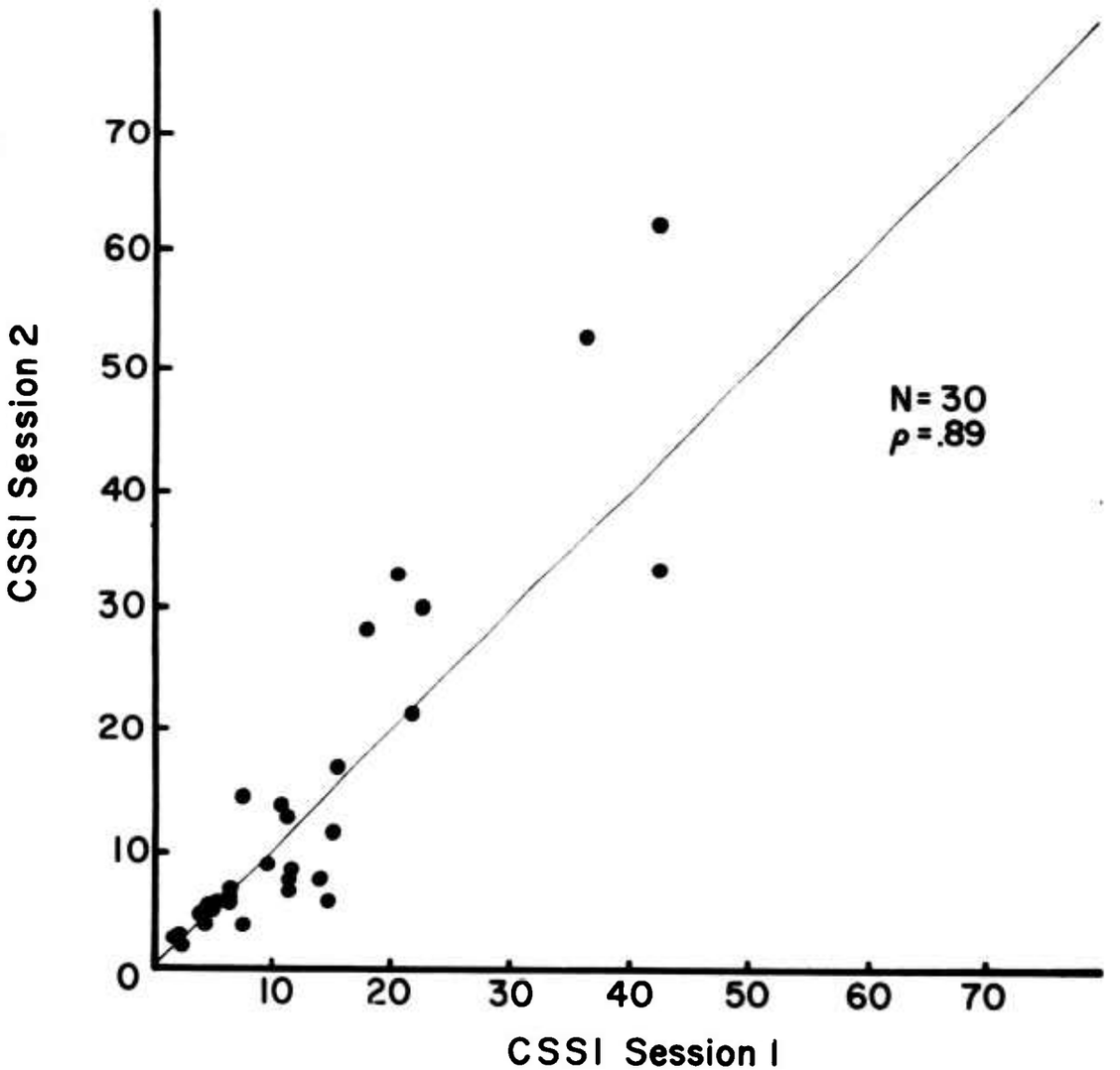


Figure 5

Scattergram of Test vs Retest Coriolis Sickness Susceptibility Indices (CSSI) of 30 Normal Subjects

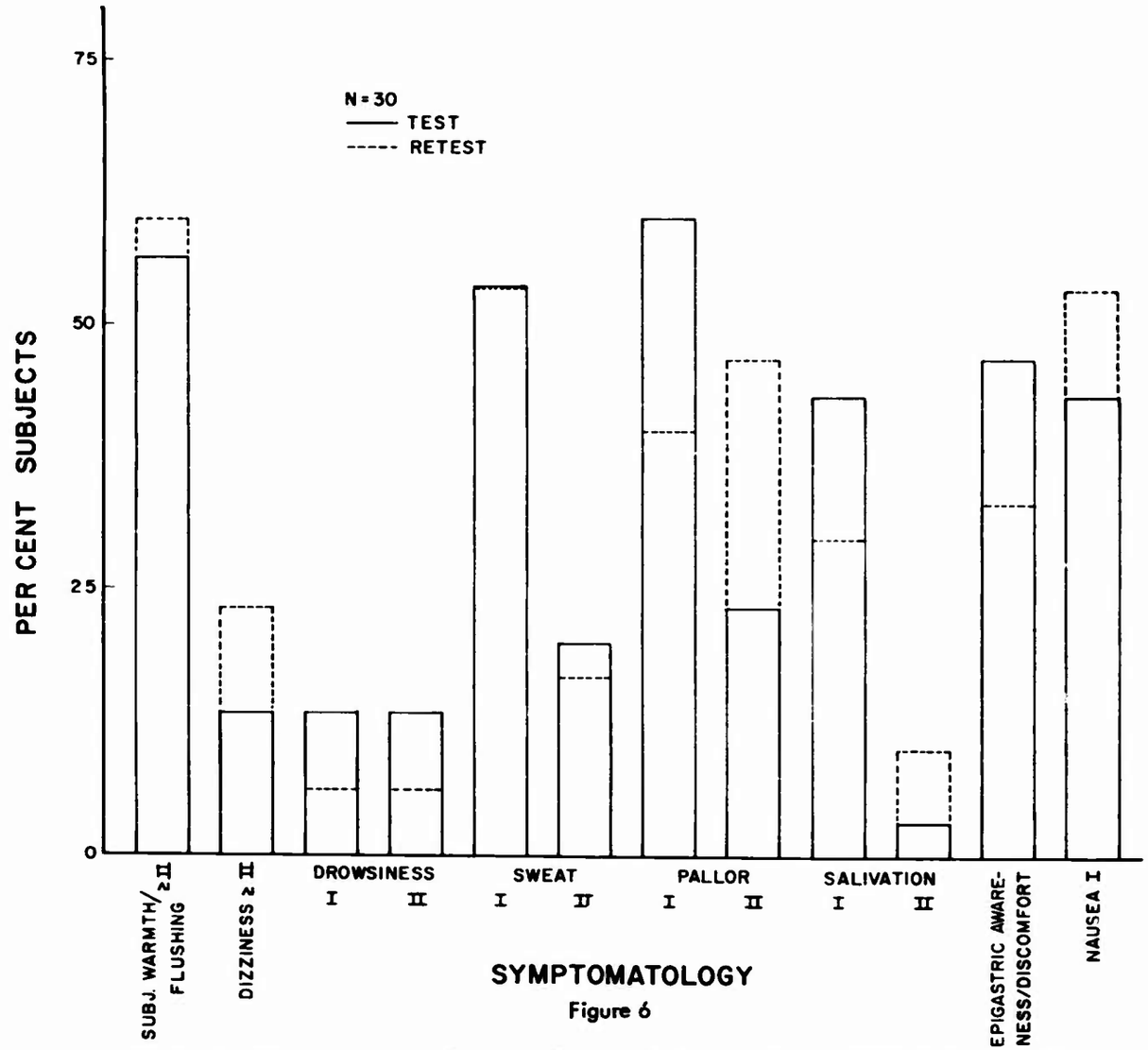


Figure 6

Similarity of Symptomatology Patterning Between the Test and Retest of Coriolis Susceptibility of 30 Normal Subjects

DISCUSSION

This study evaluated a new procedure for measuring susceptibility to Coriolis acceleration which was scaled according to the strength of the stimulus necessary to evoke severe malaise (M III). As this test was initially conceived, the stimulus parameter would have been the number of standardized head movements required to provoke a given malaise level. It was discovered in preliminary investigations, however, that one rate of rotation could not provide the latitude necessary to scale wide individual differences in motion sickness susceptibility or the stressor level necessary to overcome all individual capacity for homeostatic compensation; consequently, the rotational velocity of the chair had to be introduced as an additional parameter.

The index of Coriolis sickness susceptibility is valid only within certain limits of the number of head movements which, in turn, are dependent upon the chair's rotational rate. Six subjects (A, B, C, D, E, F, Figure 7) were selected from the 250 normal ones to serve as examples of the difference in the rate of the buildup of symptoms and to illustrate the need for careful selection of chair velocity. An ideal type of response in terms of rate of symptom buildup falls near to or within the limits represented by subjects D and E. As a rule, it was extremely difficult, if not impossible, at times to prevent a skyrocketing of symptoms up to the level of frank sickness (FS), as illustrated by subjects A and B who illustrate the typical response obtained when the rpm is too high for the individual; if, on the other hand, the rpm selected for him is too low, he can continue to make head movements without provoking any symptoms (subject F). There were other subjects who at first displayed mild symptoms, but these decreased and disappeared as the test progressed; however, when each of these subjects was retested at an rpm which yielded stressor conditions above that for which he could compensate, a pattern of response similar to that of subjects D and E was seen.

The rest period between head movement sequences was found to be short enough so that any appreciable recovery from previous vestibular Coriolis stimulation did not occur, yet it allowed for the characteristic lag in the appearance of motion sickness symptoms after each exposure to a head movement sequence. During this period the subject could be questioned fully and observed closely for any signs of malaise that might appear on his face.

The distribution of Coriolis sickness susceptibility index (CSSI) values among the population of 250 unselected normal subjects of this study revealed that most normal individuals are moderately or highly susceptible to Coriolis stress; therefore, the suggested binomial distribution function (17) is inappropriate. The fact that our population of subjects was formed predominantly of flight personnel would seem to indicate that substantial adverse response to Coriolis acceleration would be the rule rather than the exception in the general population.

The essentiality of the vestibular organs in the genesis of motion sickness was again demonstrated by the fact that the subjects lacking the function of these organs remained symptomless when exposed to the severest Coriolis acceleration provided by

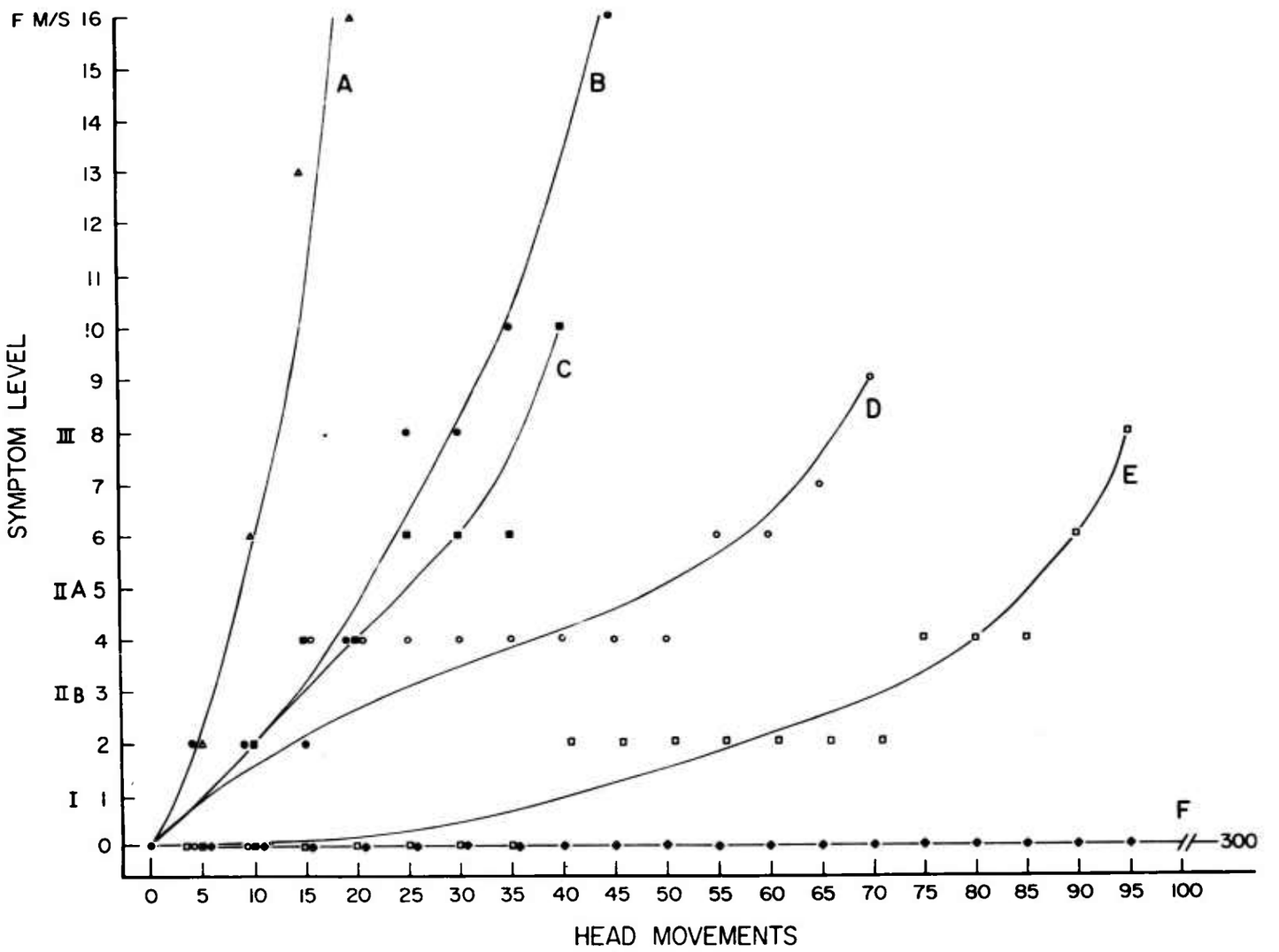


figure 7

Variations in the Rate of Symptom Buildup in Response to Head Movement as Illustrated by Six Selected Subjects (A through F)

this test. On the other hand, the fact that three of the subjects with confirmed normal vestibular function were similarly resistant to the same stressful conditions reveals that the corollary is not always true and demonstrates the marked individual differences in susceptibility which occur among normal subjects.

With the aid of one minor qualification, the diagnostic criteria for categorizing different levels of severity of acute motion sickness as reported previously (1) served without exception in quantitatively grading the susceptibility of all subjects. The need to alter the original schema was revealed when a large percentage (72.4%) of the 250 subject group (Figure 3) reported an acute increase in apparent body warmth of $>$ II intensity which was occasionally but not usually accompanied by flushing, the objective counterpart of elevated skin temperature. For this reason, moderate or greater increase in the subject's feeling of warmth ("subjective sensation") was regarded in this test as equivalent to flushing, and, singly or in combination with flushing, was identified as an Additional Qualifying Symptom (AQS) with a value of a single point.

Either nausea I, epigastric discomfort, or epigastric awareness was the predominant feature of severe malaise (III). However, a proportion of the test population (9.6%) failed to manifest even the mildest form of gastrointestinal disturbance. This finding is not in agreement with the classical viewpoint which, for the most part, equates motion sickness with a gastrointestinal reaction marked by nausea or vomiting. If M III as diagnosed by a nonnausea symptom complex is equivalent, in terms of the subject's well-being, his psychomotor efficiency, or some other indicator, to that involving the nausea syndrome, then the restricted "nausea syndrome" criterion of motion sickness must be reevaluated. In many of the subjects in whom an 8-point accumulative score was reached without epigastric involvement, the symptoms were, for the most part, effectively localized in the head region; e.g., moderate or severe levels of drowsiness to the point of being unable to follow instructions, headache, facial pallor, severe dizziness, and increased salivation.

Attention was given in the design of this test to factors which would reduce or, if possible, eliminate habituation. Moving the head in different directions for a limited number of times, covering the eyes, and if the test was repeated, reversing the direction of rotation (CW, CCW) were procedures introduced to increase the complexity of the stimulus, and to decrease experiential factors, thereby reducing the subject's ability to habituate to the test conditions. Furthermore, a chair velocity was carefully selected which would stress the individual at a level greater than his capability for making compensatory adjustments; i.e., above his functional vestibular reserve. These procedures probably contributed to the high test-retest reliability in this and in a preceding study (18).

The stability of the results, which are expressed quantitatively within a single scale of values, renders this test highly useful in specifying individual susceptibility as well as in determining the influence of a variety of factors (e.g., drugs, training) upon this basic measurement. Simplicity of the test, the short time period required, and use of apparatus commonly found in a vestibular laboratory are practical advantages.

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APPENDIX A

MOTION EXPERIENCE QUESTIONNAIRE

INSTRUCTION FOR THE EXAMINER

In attempting to evaluate motion sickness susceptibility based upon this (historical) account by the subject, two primary factors are used: 1) type and number of exposures to motion and 2) the effects in terms of the average intensity of symptoms which were recalled in these experiences. These factors, the subject's experience ($\underline{X}$) and intensity of symptoms ($\underline{S}$) for each of the motion environment categories, are identified in the Questionnaire by $\underline{X}$ and $\underline{S}$ and coded on a five-point scale. If symptoms are indicated for the "Swings and other Gymnastic Equipment" category (page A-4) its $\underline{X}$ and $\underline{S}$ values are used in the calculations; otherwise, this category is omitted entirely. The fact that this category is infrequently used increases its significance when filled in, and the $\underline{X}$ and $\underline{S}$ values are arbitrarily weighted by a factor of 2 x. The average of the 9 (or 10) $\underline{X}$ and 10 (or 11) $\underline{S}$ values are used in conjunction with a table that lists the appropriate empirically derived estimate of the chair velocity to be used in testing each subject.

MOTION EXPERIENCE QUESTIONNAIRE
PART I

Name_____ Date: Mo____ Da_____ Yr_____ Age: Yrs__ Mo___

Serial No._____ Rank or Rate_____ Designator_____

Circle: Male or Female Date of birth_____ Weight____ Height____ Handedness R L

Referral source_____

Referral problem and/or diagnosis_____

Circle one or more of the following:

Navy Marine Air Force Coast Guard Civilian

Astronaut Aviator Navigator Flight Surgeon Aircrewman

Line Officer Staff Corps Officer Student Aviator AOC Enlisted Other (Specify)___

PART II

NOTE: All yes and no questions to be answered by code: 1 for yes, 0 for no.

1. Have you ever filled out this questionnaire before? Code Answer:_____
   If yes, when?_____

2a. Do you wear a lens correction? Code Answer:_____
   b. Do you have an eye muscle defect? Code Answer:_____

3. Do you have a hearing defect?

	Right Ear	Left Ear	Both Ears	None
Code:	R	L	B	0

Code Answer:_____

Describe_____

4. Do you wear a hearing aid? Code Answer:_____

5. Experience with Scuba Diving. Yes-No Code Answer:_____
   a. Number of Exposures:

None	Less Than 10	10-50	50-200	200-500	More than 500
0	1	2	3	4	5

Code Answer:_____

b. Average Depth_____ Maximum Depth_____

c. Dives made in the past week_____
Depth (feet)_____ Duration (Hrs., Min.)_____
Dates:_____

6. Experience with high g force.
Times exposed to 3-5 g : None 1-5 5-10 10-20 20-30 Over 30
Code: 0 1 2 3 4 5
Code Answer:_____
No. of times exposed to greater than 5 g: None 1-3 3-5 5-10 10-20 Over 20
Code: 0 1 2 3 4 5
Maximum g exposure_____ Code Answer:_____

7. Number of years experience with firearms.

	None	1 yr	1-3 yrs.	3-5 yrs.	5-10 yrs.	More than 10 yrs.
Code:	0	1	2	3	4	5

Code Answer:_____
Trigger with right (Code R) or left (Code L) hand? Code Answer:_____

Average number of pistol rounds fired per year:_____

Average number of rifle rounds fired per year:_____

8. Exposure to high intensity noise?

If YES (Code 1), describe. Code Answer:_____

9. Have you ever had an ear illness or any injury or illness which was accompanied by dizziness and/or nausea? Code Answer:_____
Approximate Date(s)_____

10. In the past 8 weeks have you been nauseated FOR ANY REASON?
If YES (Code 1), explain. Code Answer:_____

a. In the past you:
Code:
0 - Were never nauseated in youth or adult life
1 - Could never vomit when nauseated
2 - Would retch and finally vomit
3 - Vomited easily Code Answer:_____

11. Have you ever had a serious head injury? Code Answer:_____
If YES:

a. When?_____

b. Describe:_____

12. Almost all pilots have had one or more experiences with vertigo and/or disorientation. How many have you had?

	None	Less than five	Five to ten	More than ten
Code:	0	1	2	3

Code Answer:_____

13. Most people experience faintness or dizziness two or three times a year which is not the result of motion. During the past year have you experienced faintness or dizziness?

	Never	Less than this	The same as this	More than this
Code:	0	1	2	3

Code Answer:_____

14. Have you been exposed to any rotational test within the past 48 hours?
If yes, describe. Code Answer:_____

PART III

Motion sickness susceptibility is revealed by a wide variety of subjective symptoms and objective signs resulting from various types of motion and may be experienced over a wide range of severity. Common symptoms are discomfort, lack of appetite, nausea, dizziness, and drowsiness; common signs are pallor, sweating, increased salivation, and vomiting. Most persons recall accurately severe symptoms but not mild symptoms which, even when experienced, may not have been attributed to motion. In identifying your motion sickness susceptibility you should relate the acute onset of symptoms to the onset of motion. Symptoms of fear and anxiety do not qualify as indicators of susceptibility to actual motion.

Indicate by the proper code taken from the appropriate table below and for each type of motion listed: I) the number of exposures and II) the intensity of the symptoms experienced during your youth and adult life.

I. EXPOSURE Code:

None	Leave Blank
1-10	1
10-25	2
25-50	3
50-100	4
> 100	5

II. INTENSITY OF SYMPTOMS

Code: None Leave Blank; Very mild 1; 2; 3; 4; Very severe 5

		General Discomfort	Nausea (Code 1-4)	Vomited or Retched (Code 5)	Stomach awareness or discomfort	Increased salivation	Giddiness, dizziness or vertigo	Drowsiness	Cold Sweating	Increased body warmth (not from exercise)	Headache	Pallor	
Swing or other gymnastic equipment													
Carnival devices	X												S
Cinerama movie													
Airplane-turbulence	X												S
Airplane-acrobatics	X												S
Airplane-Zero "g" maneuvers	X												S

2 a. Number of hours in multi-engine aircraft. (Circle one or more of the following: Passenger, Crew, Military, Commercial).

Hours:	None	Less than 10	10-50	50-200	200-1000	More than 1000
Code:	0	1	2	3	4	5

Code Answer:X_____

b. Number of hours in single-engine aircraft. (Circle one or more of the following: Passenger, Crew, Military, Commercial)

Hours:	None	Less than 10	10-50	50-200	200-1000	More than 1000
Code:	0	1	2	3	4	5

Code Answer:X_____

c. From your flying experience where unusual motion is felt would you say that you:

	No flying experience	Never get sick	Rarely get sick	Sometimes
Code:	Leave Blank	0	1	2

	Frequently	Most of the time	Always
Code:	3	4	5

Code Answer:S_____

3 a. How many exposures have you had to (moderate to violent) wave motion in a ship or boat?

Exposure:	None	1-5	5-10	10-50	50-100	Over 100
Code:	0	1	2	3	4	5

Code Answer:X_____

b. From your experience at sea what is your (a) average level and (b) maximum level of symptoms when there is moderate to violent wave motion:

Average intensity of symptoms:

	None					Severe (Vomited)
Code:	0	1	2	3	4	5

a. Code Answer (Average):S_____
b. Code Answer (Maximum):S_____

4. In general, how susceptible to motion sickness are you?

	Not at all	Minimally	Slightly	Moderately	Very	Extremely
Code:	0	1	2	3	4	5

Code Answer:S_____

5 a. Have you ever taken part in any activities which involved unusual body rotation (dance, game, etc.)? YES (Code 1) NO (Code 0)

Code Answer:_____

b. What were they? _____

c. How severe was the motion?

Very mild				Very severe
1	2	3	4	5

Code Answer: X

d. What was the average intensity of these symptoms?

Very mild				Very severe
1	2	3	4	5

Code Answer: S

e. What were your specific symptoms?

_____

6. How prone are you to car sickness?

	Not at all	Minimally	Slight	Moderately	Very	Extremely
Code:	0	1	2	3	4	5

Code Answer: S

7. It is thought that there are two kinds of motion sickness. One starts in the brain (dizziness, sleepiness) and the other one starts in the stomach or intestines (vomiting, nausea). Which would you say was typically most like yours?

	Brain	Stomach	
Code:	B	S	Code Answer: _____

8 a. Identify by code the general level of motion sickness susceptibility of your blood relatives when exposed to substantial motion (at sea, in flight or carnival devices, etc.).

Code:			Blood relative:	
Leave Blank	-	Unknown	Father	Code Answer: _____
0	-	Never gets sick	Grandfather	Code Answer: _____
1	-	Rarely gets sick	Grandmother	Code Answer: _____
2	-	Sometimes	Mother	Code Answer: _____
3	-	Frequently	Grandfather	Code Answer: _____
4	-	Most of the Time	Grandmother	Code Answer: _____
5	-	Always	Other	Code Answer: _____

APPENDIX B

Subject's Preexperimentation Questionnaire

Name/Number	Date	Time
Last First Middle Initial		
Have you been well throughout the past week? YES NO		
Are you free of all major health complications? (e.g. heart disease, diabetes, back trouble, etc.) YES NO		
Are you in your usual state of fitness today? YES NO		
If no to one or more of the above questions, specify problem and include severity, time course, where localized, etc.		
How much alcohol have you consumed during the past 24 hours? (No. and kinds of drinks)		
How much tobacco in past 3 hours? Cigarette(s) Cigar(s) Pipe(s) full		
Have you taken drugs or medicine of any kind in past 24 hours? YES NO		
If yes, were they? Analgesic (aspirin) Sedative or tranquilizer Anti-motion sickness remedy (Anti-histamine) Other, including eye and ear drop medications	If name of drug(s) is known, please list below: _____ _____ _____	
How many hours sleep did you get last night? Was this sufficient? YES NO		
How anxious are you regarding your participation in these tests? NOT MINIMAL MODERATE GREAT VERY GREAT		
How many hours since your last meal?		
How many cups of fluid have you had in the past 2 hours?		
Have you served as a subject in any rotational test within the past 48 hours? YES NO		
If yes, endpoint reached.		

APPENDIX C

Sheet for Scoring Specific Signs and Symptoms of Motion Sickness

Symptom Level	Pt. Val.	Principal Symptoms*								RPM	CW	CCW
		TMP[1]	DIZ[2]	HAC[3]	DRS[4]	SWT[5]	PAL[6]	SAL[7]	NSA[8]			
Major	8				III	III	III	III	II, III			
Minor	4				II	II	II	II	I			
Minimal	2				I	I	I	I	E. D.[9]	Other Symptoms		Mulaise Level
AQS	1	II, III	II, III	II, III					E. A.[10]			
Head Movements 5												
10												
15												
20												
25												
30												
35												
40												
45												
50												
55												
60												
65												
70												
75												
80												
85												
90												
_00												

*Based on criteria of Table I.

[1]Subjective warmth/flushing
[2]Dizziness
[3]Headache
[4]Drowsiness
[5]Cold sweating
[6]Pallor
[7]Salivation increase
[8]Nausea
[9]Epigastric Discomfort
[10]Epigastric Awareness

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13. ABSTRACT

A standard method developed for quantifying Coriolis (motion) sickness susceptibility was evaluated in 250 normal and three labyrinthine-defective subjects. The procedure required the subject to execute standard head movements (±90° in the frontal and sagittal planes) while seated in a chair device that was rotated at one of several constant velocities. The proper test velocity was predicted in the majority of cases with the Motion Experience Questionnaire. Three of the normal and all of the labyrinthine-defective subjects were found to be unsusceptible to these test conditions. Coriolis Sickness Susceptibility Index, CSSI, was determined for each subject by multiplying the appropriate E factor, the average stress effect of each head movement for the rpm used in the test, by the number of head movements required to provoke severe malaise (M III). The resultant CSSI values for the 250 subjects ranged from 0.4 to 100, but the distribution was markedly right skewed. The procedure yielded a high test-retest reliability ($\rho = .89$) in terms of CSSI scores and pattern of symptomatology. In reaching the Malaise III level, the nausea syndrome was manifested in most cases, but a significant percentage (~~14~~ 9.6%) of the subjects remained free of any epigastric disturbance or nausea.

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Coriolis acceleration						
Vestibular organs						
Stress						
Susceptibility Test						
Head movement						